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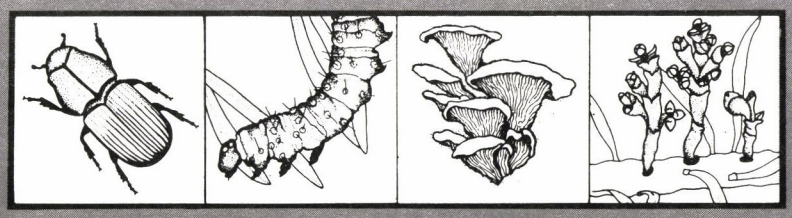

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STUDIES OF *FUSARIUM* ASSOCIATED WITH CONTAINERIZED CONIFER SEEDLING DISEASES: (2). DISEASES OF WESTERN LARCH, DOUGLAS-FIR, GRAND FIR, SUBALPINE FIR, AND PONDEROSA PINE SEEDLINGS AT THE USDA FOREST SERVICE NURSERY, COEUR D'ALENE, IDAHO

by

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ABSTRACT

Containerized western larch, Douglas-fir, grand fir, subalpine fir, and ponderosa pine seedlings which displayed disease symptoms were sampled for presence of *Fusarium* spp. Seedlings from 33 seedlots within the Northern Region were sampled. Major types of diseases included post-emergence damping-off, root disease (late damping-off), and cotyledon blight. *Fusarium oxysporum* was most frequently isolated from seedlings; *F. avenaceum* was also commonly isolated, particularly from grand fir and subalpine fir seedlings. Both fungal species often produced orange sporodochia on diseased seedlings. Poor production from several high elevation Douglas-fir seedlots was probably due to losses from seed-borne Fusaria.

INTRODUCTION

Fusarium spp. are important soil-borne plant pathogens that attack many different kinds of plants including conifer seedlings. Types of containerized seedling diseases associated with *Fusarium* spp. include seed decay, pre-emergence damping-off or germination failure, post-emergence damping-off, top damping-off or cotyledon blight, and root disease or late damping-off (Bloomberg 1971; Matuo and Chiba 1966).

Most conifers are susceptible to *Fusarium* root disease, although Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is often the species most damaged (James 1984a). Different species of *Fusarium* have been frequently isolated from containerized conifer seedlings, the most common of which is *F. oxysporum* Schlect. (Graham and Linderman 1983; James 1984a).

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Periodic losses from diseases caused by Fusarium have occurred at the USDA Forest Service Nursery, Coeur d'Alene, Idaho. Therefore, an evaluation was conducted to investigate types of diseases and associated Fusarium spp. on five different conifer species grown during 1984 at the nursery. Since intensity of these diseases may vary among different seedlots (James 1985; James and Gilligan 1985), comparisons of disease occurrence were made among selected Douglas-fir seedlots.

MATERIALS AND METHODS

Periodic inspections of containerized western larch (Larix occidentalis Nutt.), Douglas-fir, grand fir (Abies grandis (Dougl.)Lindl.), subalpine fir (Abies lasiocarpa (Hook.) Nutt.), and ponderosa pine (Pinus ponderosa Laws.) seedlings were made at the nursery. Seedlings with disease symptoms (chlorotic or necrotic foliage, dwarfing, and mortality) and seed or seedcoats with prominent fungal sporulation were collected and taken to the laboratory for isolation of associated organisms. All isolations were made on a selective medium for Fusarium (Komada 1975). Isolates of Fusarium were grown on carnation leaf agar (CLA) (Fisher et al. 1982) and identified using standard taxonomic keys (Booth 1966; Gerlach and Nirenberg 1982).

Four Douglas-fir seedlots which exhibited high levels of disease were selected for more intensive sampling when seedlings were about 10 weeks old. Two trays (400 cells) of small Leach tubes were randomly selected for each seedlot. Number of seedlings in two disease categories were counted. The categories were (1) seedlings which were completely necrotic (root diseased) and (2) seedlings with foliage or stem tip dieback. Also, the number of cells with diseased seed, i. e., that with prominent fungal sporulation, and number of empty cells (without seedlings) were also counted. Several of the diseased seed and seedlings were taken to the laboratory for isolation work.

RESULTS AND DISCUSSION

Diseased seedlings were sampled from 14 western larch and Douglas-fir, two ponderosa pine andgrand fir, and one subalpine fir seedlots (table 1). The major types of diseases encountered were post-emergence damping-off, cotyledon blight, and root disease (late damping-off). With the exception of cotyledon blight, these diseases were found on all conifer species sampled. Cotyledon blight was most prevalent on ponderosa pine, which tends to retain seedcoats on their cotyledons longer than other species.

Table 1.--Western larch, Douglas-fir, grand fir, subalpine fir, and ponderosa pine seedlots sampled for diseases associated with Fusarium spp. at the USDA Forest Service Nursery, Coeur d'Alene, Idaho.

Species[1]	Seedlot	National Forest	Ranger District	Types of diseases[2]	Associated Fusarium spp.[3]
WL	0926	Lolo	Seeley Lake	RD	F. oxy.
WL	4103	Kootenai	Fortine	RD	None
WL	4114	Kootenai	Rexford	RD	F. oxy.
WL	4216	Kootenai	Rexford	RD	None
WL	4265	IPNF[4]	Bonners Ferry	RD	None
WL	4295	Clearwater	Powell	RD	None
WL	4317	Lolo	Superior	RD	None
WL	4326	Lolo	Superior	RD	None
WL	4808	IPNF	Avery	DO	F. ave.
WL	4885	Bitterroot	Stevensville	RD	F. oxy.
WL	6114	Kootenai	Rexford	RD	F. oxy.
WL	6174	Kootenai	Rexford	RD/DO	F. oxy.
WL	6210	IPNF	Fernan	RD	None
WL	6221	IPNF	Sandpoint	RD	None
DF	1081	Beaverhead	Wisdom	RD	F. oxy.
DF	2129	Kootenai	Rexford	RD	F. oxy.
DF	2445	Clearwater	Powell	RD	F. oxy.
DF	2482	Lolo	Plains	RD	F. oxy.
DF	2703	Nezperce	Elk City	RD/DO	F. oxy./F. ave.
DF	4322	Lolo	Plains	RD/DO	F. ave.
DF	4570	Clearwater	Pierce	RD	F. oxy.
DF	4583	Clearwater	Pierce	RD	F. oxy./F. ave.
DF	4861	Deerlodge	Jefferson	RD	F. oxy.
DF	4884	Bitterroot	West Fork	RD	F. oxy.
DF	4907	IPNF	Red Ives	RD	F. ave.
DF	6070	Gallatin	Hebgen Lake	RD	F. oxy.
DF	6073	Gallatin	Hebgen Lake	RD	F. oxy.
DF	6700	Gallatin	Livingston	RD	F. oxy.
GF	4929	IPNF	Red Ives	RD/DO	F. ave.
GF	6096	Nezperce	Elk City	RD/DO	F. ave.
SAF	4939	IPNF	Bonners Ferry	RD/DO	F. ave.
PP	0549	Kootenai	Fisher River	RD/CR	F. oxy.
PP	0684	Helena	Helena	RD/CR	F. oxy.

[1] WL = western larch; DF = Douglas-fir; GF = grand fir; SAF = subalpine fir; PP = ponderosa pine.

[2] RD = root disease (late damping-off).
DO = post emergence damping-off
CR = cotyledon rot

[3] F. oxy. = Fusarium oxysporum; F. ave. = Fusarium avenaceum.

[4] Idaho Panhandle National Forests.

Fusarium spp. were obtained from diseased seedlings in all the Douglas-fir, grand fir, subalpine fir, and ponderosa pine seedlots sampled (table 2). However, Fusarium was isolated from diseased seedlings in only six of 14 western larch seedlots sampled. Two species of Fusarium were consistently isolated from seedlings: F. oxysporum and F. avenaceum (Fr.) Sacc. Detailed descriptions of these organisms are included in the Appendix.

Fusarium oxysporum was most frequently isolated from diseased seedlings and associated with all types of diseases. This common pathogen is a major cause of damping-off of young seedlings (Graham and Linderman 1983; James and Gilligan 1985; Landis 1976) and needle tip dieback and mortality of older seedlings (James 1984a; James 1984b) grown in greenhouses.

Fusarium avenaceum was isolated from all species except ponderosa pine. The fungus was most prevalent on grand fir and subalpine fir seedlings, where it often produced orange sporodochia on necrotic seedlings just above the soil line. Since F. oxysporum also produces orange sporodochia on diseased seedlings (James and Gilligan 1985; Landis 1976), isolations are usually required to determine which species is involved. F. avenaceum occurs world-wide and especially in temperate zones (Gerlach and Nirenberg 1982). The fungus is most often isolated from cereals, but has also been obtained from numerous other plants. F. avenaceum is sometimes an aggressive damping-off pathogen (Schneider 1958). Although it has been isolated from diseased conifer seedlings on several occasions (James and Gilligan 1985; Wenner and Merrill 1984), role of the fungus in causing seedling diseases is unknown and needs investigation.

Production problems were encountered in four high elevation Douglas-fir seedlots from the Gallatin, Deerlodge, and Beaverhead National Forests (table 2). High percentages of the cells failed to produce seedlings, which may indicate extensive pre-emergence damping-off losses. Diseased seedlings in these lots always yielded F. oxysporum, which was also frequently recovered from seed or seedcoats. Therefore, it appears that F. oxysporum probably was responsible for the poor seedling production in these high elevation seedlots.

Table 2.--Occurrence of Fusarium root disease on containerized Douglas-fir seedlings at the USDA Forest Service Nursery, Coeur d'Alene, Idaho.[1]

Seedlot			PERCENT OF CELLS				
			Diseased seedlings				
National Forest	Number	Elevation (ft)	Tip blight	Root diseased	Diseased seed	Empty cells[2]	Total cells sown
Beaverhead	1081	7000	1.5	1.0	3.5	32.3	15,400
Deerlodge	4861	7200	0	0.8	0.8	6.8	14,200
Gallatin	6037	6700	0.5	0.3	1.0	14.8	10,600
Gallatin	6070	6800	2.5	1.5	1.0	7.8	15,400

[1] 400 cells (two Leach trays) were sampled from each seedlot.
[2] Cells without emerged seedlings.

This evaluation indicates that F. oxysporum and F. avenaceum are important disease organisms that may frequently affect production of containerized conifer seedlings at the USDA Forest Service Nursery in Coeur d'Alene. Although tests to confirm pathogenicity were not conducted, their frequent association with diseased seedlings indicates that these fungi were likely involved in disease initiation. Both fungi were probably seedborne (James 1985); secondary disease spread from inoculum produced on necrotic seedlings probably also occurred. To reduce losses from these diseases, periodic removal of infected seedlings from greenhouses is recommended. If certain seedlots with extensive infection can be identified, seed sterilization with hydrogen peroxide or fungicides may be needed (James 1985). Careful screening of consistently troublesome seedlots, such as those from high elevations which often produce fewer seedlings, may improve production.

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APPENDIX

Descriptions of Fusarium spp. commonly isolated from containerized western larch, Douglas-fir, grand fir, subalpine fir, and ponderosa pine seedlings at the USDA Forest Service Nursery, Couer d'Alene, Idaho:

Fusarium oxysporum Schlect. (Isolates 84-46, 84-50, 85-115)

- colonies fast-growing, reaching 7.6-9.6 cm in diameter in 7 days at 22°C on potato dextrose agar (PDA).
- colonies either moist or with floccose aerial mycelium which is white to slightly ochre in color.
- all isolates produce violet pigment which is most pronounced at the agar surface. Intensity of pigment varies among isolates.
- microconidia abundant within the aerial mycelium, cohering in false heads and borne on short, generally unbranched phialides. Microconidia 1-2 celled, cylindric to ellipsoid and measure 6-15 x 2.5-3.5 u.
- macroconidia at first produced solitarily and sparsely. Orange sporodochia produced readily on CLA which give rise to abundant 3-5 septate macroconidia. Macrocondia falcate, usually moderately curved, equally tapering towards both ends, with a pointed apical cell and a distinct pedicellate basal cell, and measure 30-48 x 3.0-5.0 u.
- chlamydospores generally abundant in hyphae and conidia, terminal or intercalary, globose to subglobose, and measure 7-11 u in diameter.

Fusarium avenaceum (Fr.) Sacc. (Isolates 84-51, 84-90, 84-91, 84-92)

- colonies fast growing, reaching 9-9.4 cm in diameter in 7 days at 22°C on PDA.
- colonies with abundant floccose aerial mycelium that is white-ochre with a dash of rose.
- deep carmine pigment produced by all isolates; pigment most pronounced at the agar surface.
- bright orange sporodochia produced by all isolates on CLA.
- no microconidia produced.
- macroconidia produced on densely branced conidiophores. Macroconidia falcate, sometimes only slightly curved, slender, with an elongated, elegantly curved, acuminate apical cell and a distinctly pedicellate basal cell, mostly 5 septate and measure 45-58 x 3.0-3.5 u.
- no chlamydospores formed.